

What is claimed is:

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1. An anode for use in a fuel cell having improved tolerance to voltage reversal, said anode comprising a first catalyst composition for electrochemically oxidizing a fuel directed to said anode and a second catalyst composition for evolving oxygen from water.

2. The anode of claim 1 wherein said fuel cell is an acid electrolyte fuel cell.

3. The anode of claim 1 wherein said fuel cell is a solid polymer electrolyte fuel cell.

4. The anode of claim 3 wherein said first catalyst composition is selected from the group consisting of precious metals, transition metals, oxides of precious metals and transition metals, alloys of precious metals and transition metals, and mixtures of precious metals and transition metals.

5. The anode of claim 3 wherein said first catalyst composition is selected from the group consisting of precious metals, alloys of precious metals, mixtures of precious metals, precious metals alloyed with transition metals, and mixtures of precious metals and transition metal oxides.

6. The anode of claim 3 wherein said first catalyst composition comprises a platinum-

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5 containing compound selected from the group consisting of platinum and an alloy of platinum and ruthenium.

7. The anode of claim 3 wherein said second catalyst composition comprises a metal oxide selected from the group consisting of precious metal oxides, mixtures of precious metal oxides, 5 solid solutions of precious metal oxides, mixtures of precious metal oxides and valve metal oxides, and solid solutions of precious metal oxides and valve metal oxides.

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5 8. The anode of claim 7 wherein said metal oxide comprises a precious metal oxide selected from the group consisting of RuO_x , IrO_x , and solid solutions of RuO_x and IrO_x , wherein x is greater than 1.

9. The anode of claim 8 wherein x is about 2.

10. The anode of claim 7 wherein said metal oxide is selected from the group consisting of RuO_2 and solid solutions of RuO_2 and IrO_2 .

11. The anode of claim 10 wherein said metal oxide comprises RuO_2 .

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12. The anode of claim 10 wherein said metal oxide comprises a solid solution of RuO_2 and IrO_2 having iridium present in an atomic ratio of ruthenium to iridium of no greater than 90:10.

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5 13. The anode of claim 7 wherein said metal oxide comprises a metal oxide selected from the group consisting of solid solutions of RuO_x and a valve metal oxide, and solid solutions of IrO_x and a valve metal oxide, wherein x is greater than 2.

14. The anode of claim 13 wherein said metal oxide comprises a solid solution of RuO_2 and a valve metal oxide.

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15. The anode of claim 14 wherein said metal oxide comprises a solid solution of RuO_2 and TiO_2 .

16. The anode of claim 14 wherein said metal oxide comprises a solid solution of RuO_2 and TiO_2 having titanium present in an atomic ratio of ruthenium to titanium of no greater than 50:50.

17. The anode of claim 14 wherein said solid solution has titanium present in an atomic ratio of ruthenium to titanium of no greater than 70:30.

18. The anode of claim 14 wherein said solid solution has titanium present in an atomic ratio of ruthenium to titanium of no greater than 90:10.

19. The anode of claim 13 wherein said metal oxide comprises a solid solution of IrO_2 and TiO_2 having titanium present in an atomic ratio of iridium to titanium of no greater than 90:10.

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20. The anode of claim 7 wherein said first catalyst composition comprises a platinum-containing compound selected from the group consisting of platinum and an alloy of platinum and ruthenium.

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21. The anode of claim 9 wherein said first catalyst composition comprises a platinum-containing compound selected from the group consisting of platinum and an alloy of platinum and ruthenium.

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22. The anode of claim 13 wherein said first catalyst composition comprises a platinum-containing compound selected from the group consisting of platinum and an alloy of platinum and ruthenium.

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23. The anode of claim 15 wherein said first catalyst composition comprises a platinum-containing compound selected from the group consisting of platinum and an alloy of platinum and ruthenium.

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24. The anode of claim 3 wherein said first catalyst composition is supported on a first electrically conductive particulate support.

25. The anode of claim 24 wherein said first catalyst composition is supported on a first carbon support.

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26. The anode of claim 3 wherein said second catalyst composition is supported on a second electrically conductive particulate support.

27. The anode of claim 26 wherein said second catalyst composition is supported on a second carbon support.

28. The anode of claim 3 wherein said first and second catalyst compositions are supported on the same electrically conductive carbon particulate support.

29. The anode of claim 26 wherein said second catalyst composition is supported on a valve metal oxide support.

30. The anode of claim 29 wherein said valve metal oxide support is a titanium oxide.

31. The anode of claim 3 wherein said first and second catalyst compositions are incorporated in a common layer in said anode.

32. The anode of claim 3 wherein said first and second catalyst compositions are incorporated in different layers in said anode.

33. The anode of claim 3 wherein said fuel stream comprises gaseous hydrogen.

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189 34. A method of making a solid polymer electrolyte fuel cell tolerant to voltage reversal, said fuel cell comprising an anode, a cathode, and a solid polymer electrolyte, said anode comprising
5 a first catalyst composition for electrochemically oxidizing a fuel directed to said anode, said method comprising incorporating a second catalyst composition in said anode for evolving oxygen from water.

35. The method of claim 34 wherein said second catalyst composition is deposited on an electrically conductive particulate support.

36. The method of claim 35 wherein said second catalyst composition is deposited on a carbon support.

37. The method of claim 36 wherein said first catalyst composition and said second catalyst composition are deposited on said carbon support.

38. The method of claim 34 wherein said anode comprises a substrate and the method comprises mixing said first and second catalyst compositions and applying the mixture to said substrate in a
5 common layer.

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39. The method of claim 34 wherein said anode comprises a substrate and the method comprises applying said first and second catalyst compositions to said substrate in two separate discrete layers, thereby forming a bilayer anode.

40. A solid polymer electrolyte fuel cell having improved tolerance to voltage reversal prepared by the method of claim 34.

41. A membrane electrode assembly comprising the anode of any one of claims 1-32.

42. A fuel cell comprising the anode of any one of claims 1-32.

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